P305 #22

Given: $m_{NaHCO_3(s)} = 5.022\,g$ all reacted (Limiting reactant)

$V_{solution} = 80.00\,mL$ $m_{ass} = 80.00\,g$, $c = 4.184\,J/g°C$

$\Delta T = T_f - T_i$
$= 28.4 - 18.6$
$= 9.8\,°C$

Required: molar enthalpy $\Delta H_r$ (reaction) kJ/mol

Plan: ① $Q_{surroundings}$ ($mc\Delta T$) kJ — $Q = \Delta H$
② $Q_{system}$
③ moles (mol)
④ molar enthalpy kJ/mol

① $Q_{surr} = m\,c\,\Delta T$ (2 S.D.)
$= (80.00)\,g \times 4.184\,\frac{J}{g°C} \times 9.8\,°C$
$= 3280.256\,J$ or $3.28 \times 10^3\,J$

② $Q_{sys} = -Q_{surroundings}$
$= -3280.256\,J$

③ $n_{limiting\ reactant} = \frac{mass\ NaHCO_3}{84.01\,g/mol}$ (48.00 + 1.01 + 12.01 + 3 × 16.00)
$= 0.0597857\,mol$

④ $\Delta H = \frac{Q_{system}}{n}$
$= \frac{-3280.256\,J}{0.0597857\,mol}$
$= -54866.899\ldots\,J/mol$

Molar enthalpy for $NaHCO_3 = -55\,kJ/mol$

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27) Given: $\Delta H_{NaOH} = -55.0\,kJ/mol$ (System)
$V = 250.0\,mL$
$C_{NaOH} = 0.100\,mol/L$
$\Delta T = ?$

Plan: $\Delta T$ is needed → $Q_{surr} = mc\Delta T$
$Q_{surr} = -Q_{system}$
$Q_{system}$ is linked to kJ/mol (Given) → $\frac{Q_{sys}}{n} = \frac{kJ}{mol}$

Solution: $n_{NaOH\ used} = C \times V$
$= 0.100 \times 0.250$
$= 0.0250\,mol$

$Q_{system} = \frac{-55\,kJ}{mol} \times 0.0250\,mol$ ($Q = \Delta H$)
$= -1.375\,kJ$

$\frac{-55\,kJ}{1\,mol} = \frac{?\,kJ}{0.0250\,mol}$ $Q = n \times \Delta H$

$\frac{Q_1}{n_1} = \frac{Q_2}{n_2}$ $Q_{surr} = +1.375\,kJ$ → $1375\,J$

$Q_{surr} = m\,c\,\Delta T$ $1375\,J$

$\frac{Q}{m \times c} = \Delta T$ $\frac{1375\,J}{250\,g \times 4.184\,J/g°C} = \Delta T$

$1.31 = °C$

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